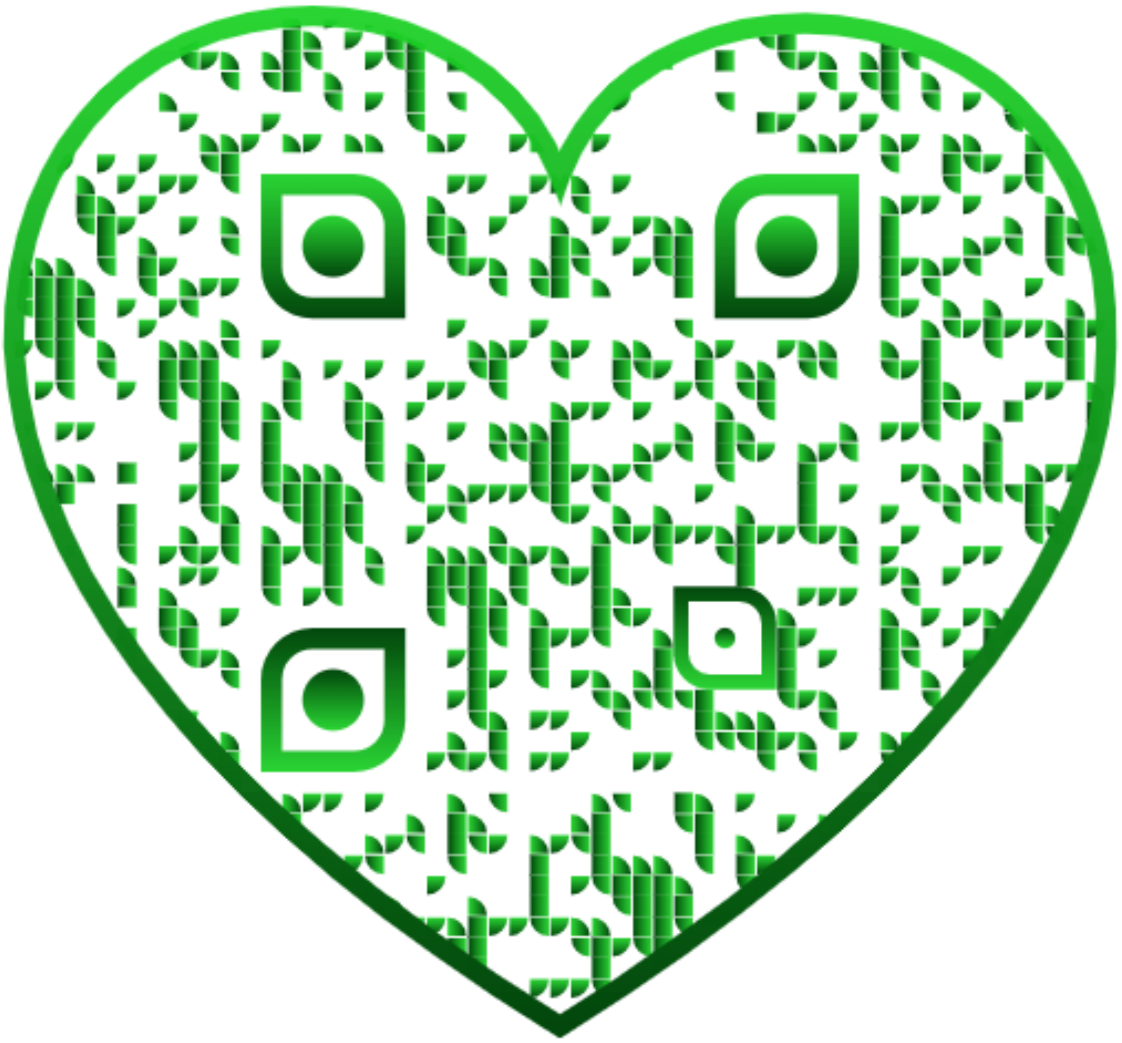
Renal system

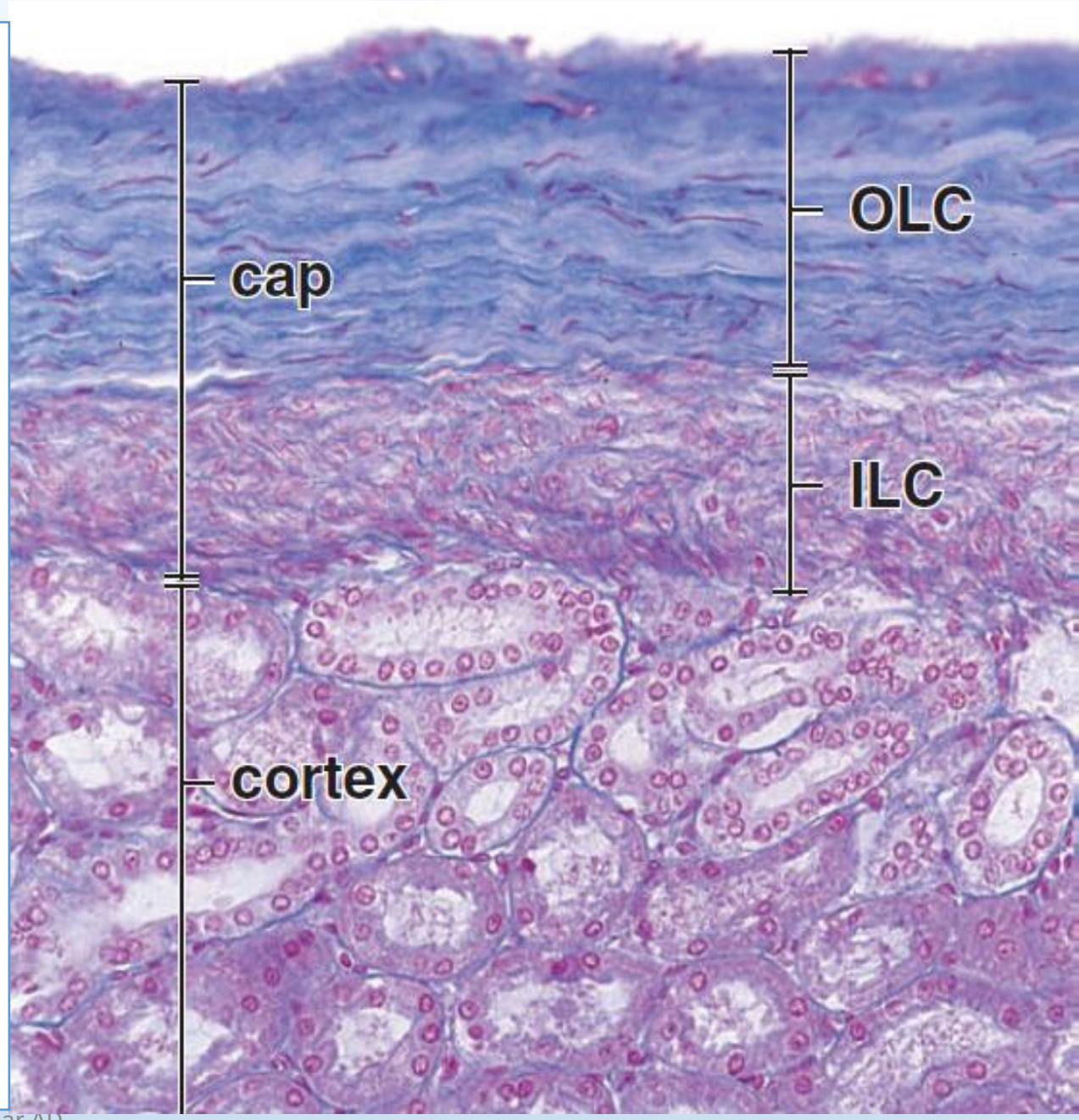
Dr. Omar AD.



Renal capsule

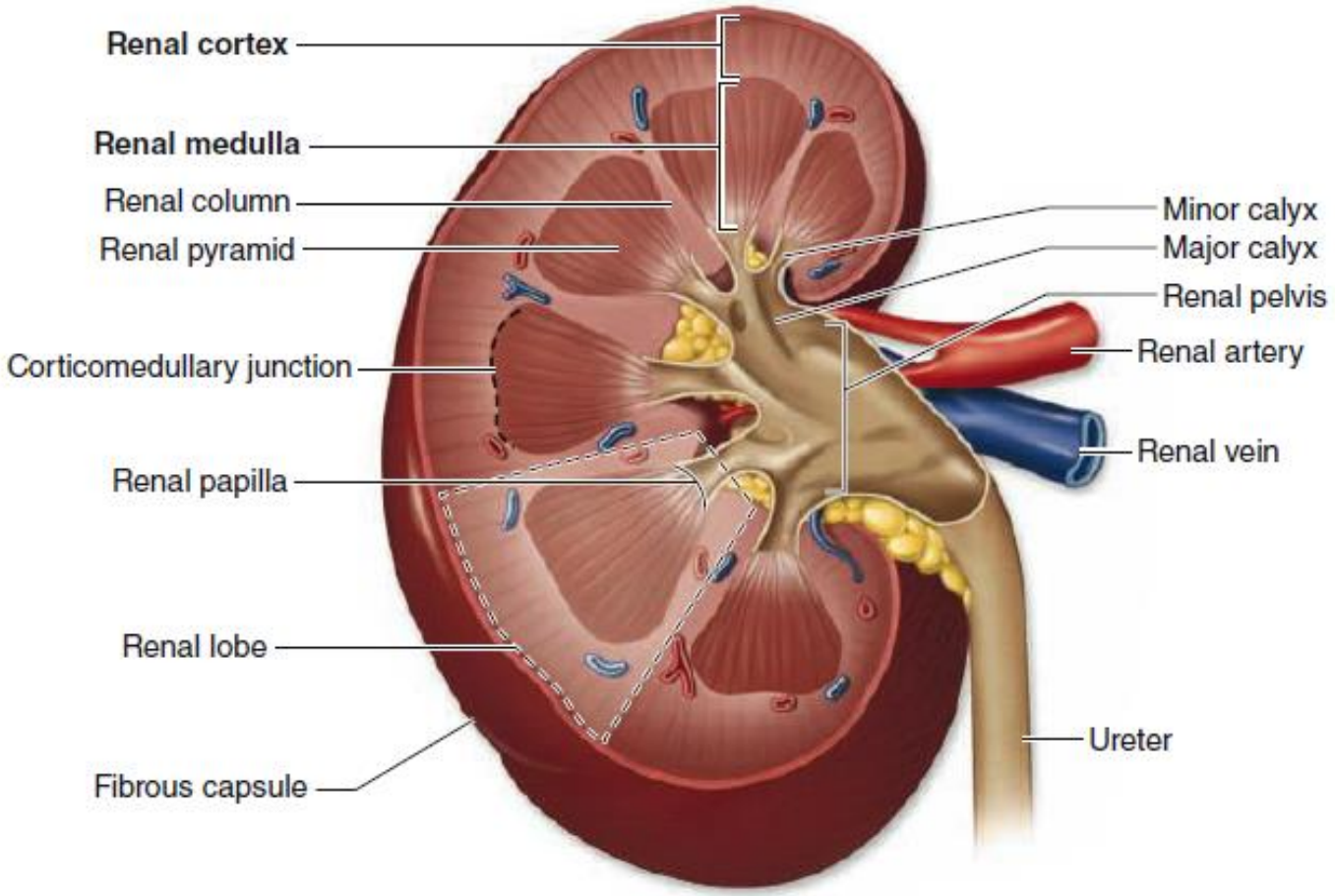
The outer layer of the capsule (OLC) is composed of **dense connective tissue**. The fibroblasts in this part are relatively few in number; their nuclei appear as narrow, elongate, red-staining profiles against a blue background representing the stained collagen fibers.

The inner layer of the capsule (ILC) consists of large numbers of **myofibroblasts** whose nuclei appear as round or elongate, red-staining profiles, depending on their orientation within the section. Note that the collagen fibers in this layer are relatively sparse and that the myofibroblast nuclei are more abundant.
Stain: Mallory-Azan.

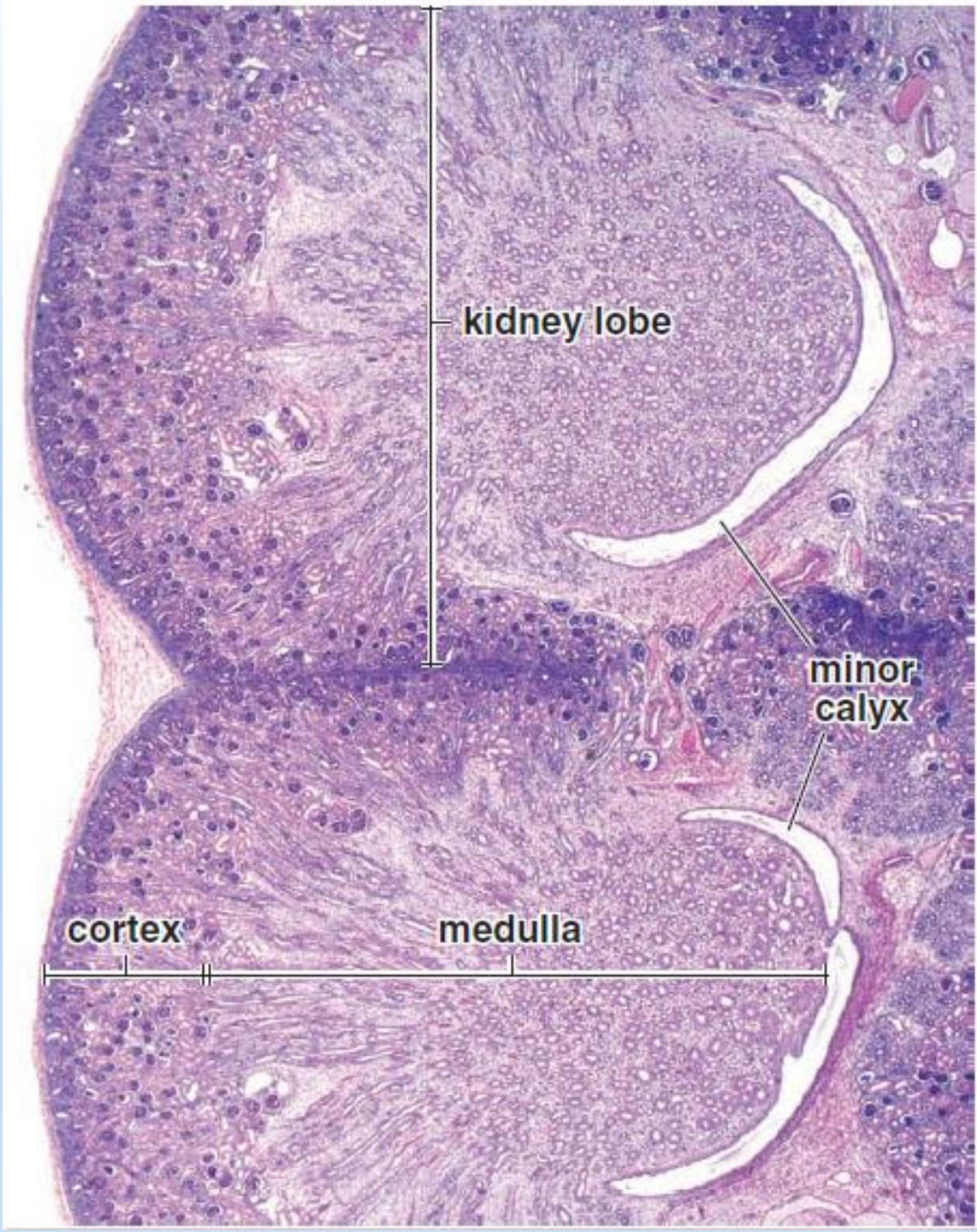


Kidney

- Each kidney has a thick outer **cortex**, surrounding a **medulla** that is divided into 8-12 renal pyramids; each pyramid and its associated cortical tissue comprises a **renal lobe**.
- The apical papilla of each renal pyramid inserts into a **minor calyx**, a subdivision of two or three **major calyces** extending from the **renal pelvis**.
- The **ureter** carries urine from the renal pelvis and exits the **renal hilum**, where the **renal artery and vein** are also located.



Fetal kidney.
This photomicrograph shows the cortex, the medulla, and two associated pyramids.
Stain: H&E.

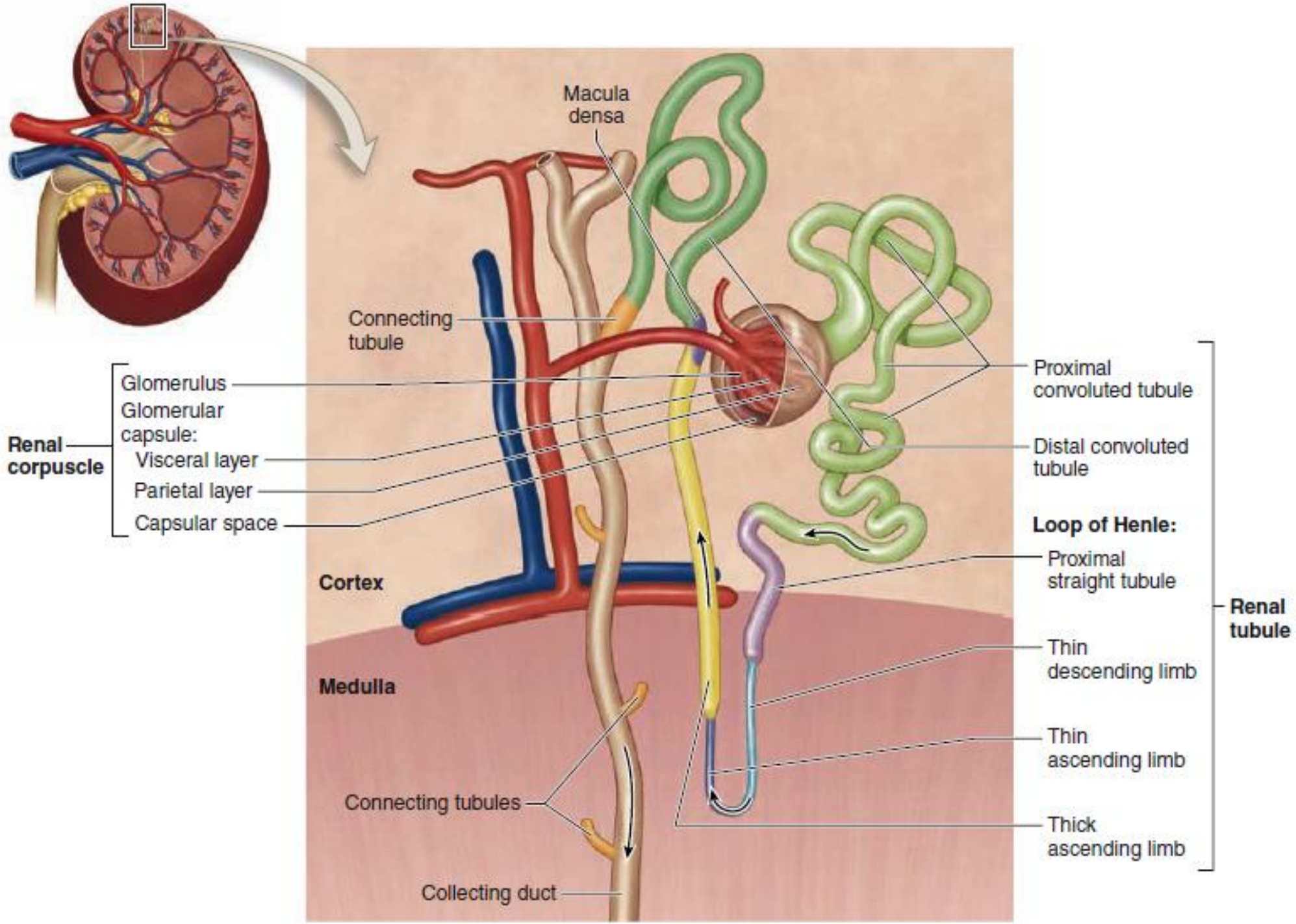


Nephrons

- Functional units of the kidney are the **nephrons**, numbering about 1 million, each with a **renal corpuscle** and a long **renal tubule**, and a system of **collecting ducts**.
- **The renal corpuscle** has a simple squamous parietal layer of the **glomerular (Bowman) capsule**, continuous with the proximal tubule, and a specialized visceral layer of **podocytes** surrounding the glomerular capillaries.
- **Podocytes** extend large primary processes that curve around a capillary and extend short, interdigitating secondary processes or **pedicels**, between which are narrow spaces called **slit pores**.
- **Mesangial cells** in renal corpuscles are located between capillaries and cover those capillary surface **not covered** by podocyte processes.
- From the renal corpuscle, filtrate enters the long **nephron tubule** that extends through both the cortex and medulla, with epithelial cells for both **reabsorption** and **secretion** of substances into the filtrate.

Nephrons

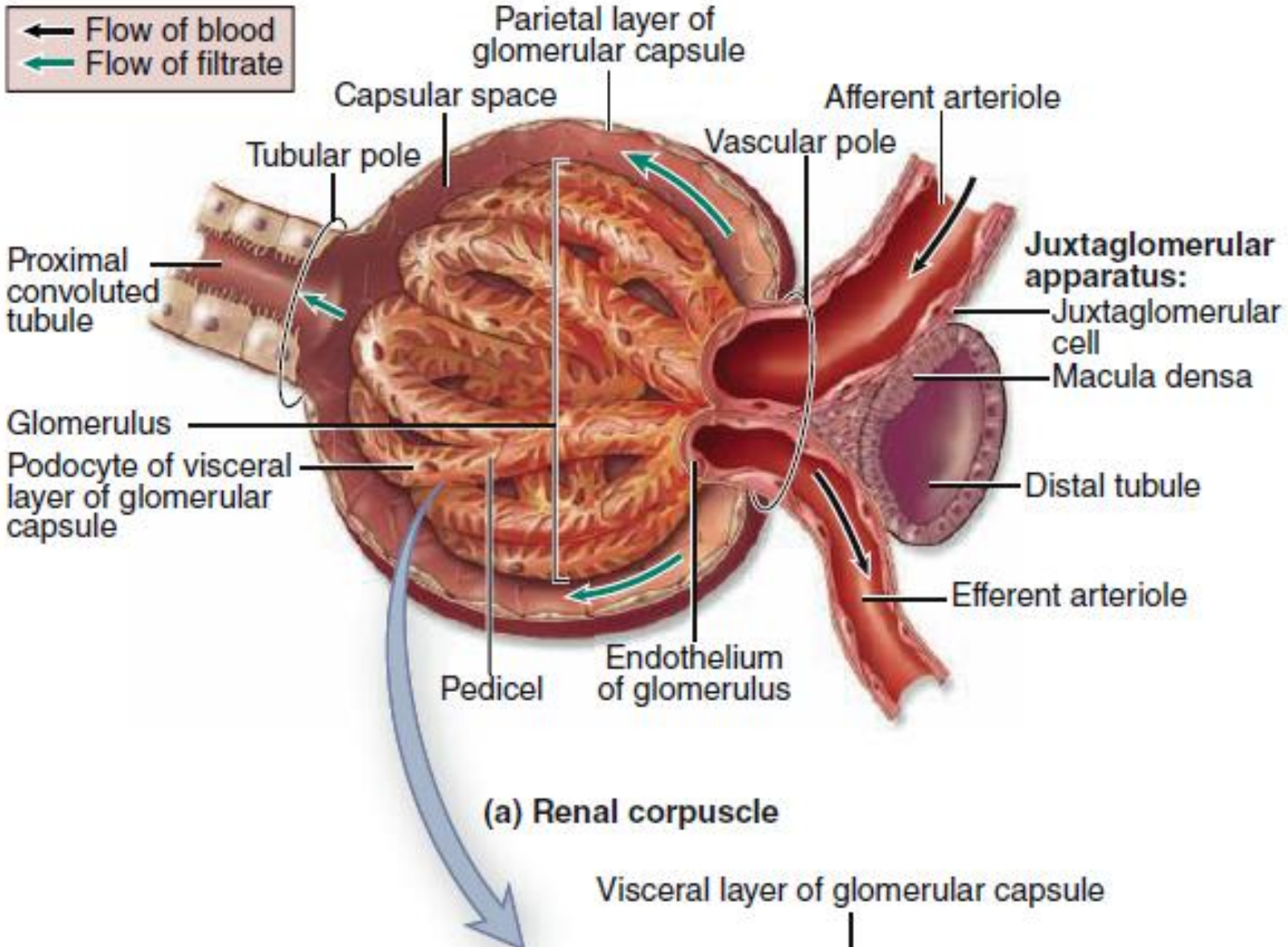
- The first tubular part, the **proximal convoluted tubule** (**PCT**), is mainly **cortical**, has **simple cuboidal** cells with **long microvilli** in the lumen, **abundant mitochondria**, and large, interdigitating **basolateral folds**.
- From the **PCT** filtrate flows into the **loop of Henle**, located in the **medulla**, which has **squamous thin descending** and **ascending limbs**; then a **thick ascending limb** (**TAL**) back into the **cortex**.
- In the cortex the **TAL** (also known as **distal straight tubule**) contacts the arterioles at the vascular pole of renal corpuscle and there thickens as the **macula densa**.
- Tall epithelial cells of the **macula densa** and specialized smooth muscle cells in the adjacent afferent arteriole called **juxtaglomerular cells**, which secrete **renin**, comprise a **juxtaglomerular apparatus (JGA)** that is an important regulator of blood pressure.
- Beyond the macula densa, the tubule continues as the **distal convoluted tubule** (**DCT**) which lead to short **connecting tubules**.
- **Connecting tubules** join to form the cortical **collecting ducts**, of simple cuboidal epithelium.

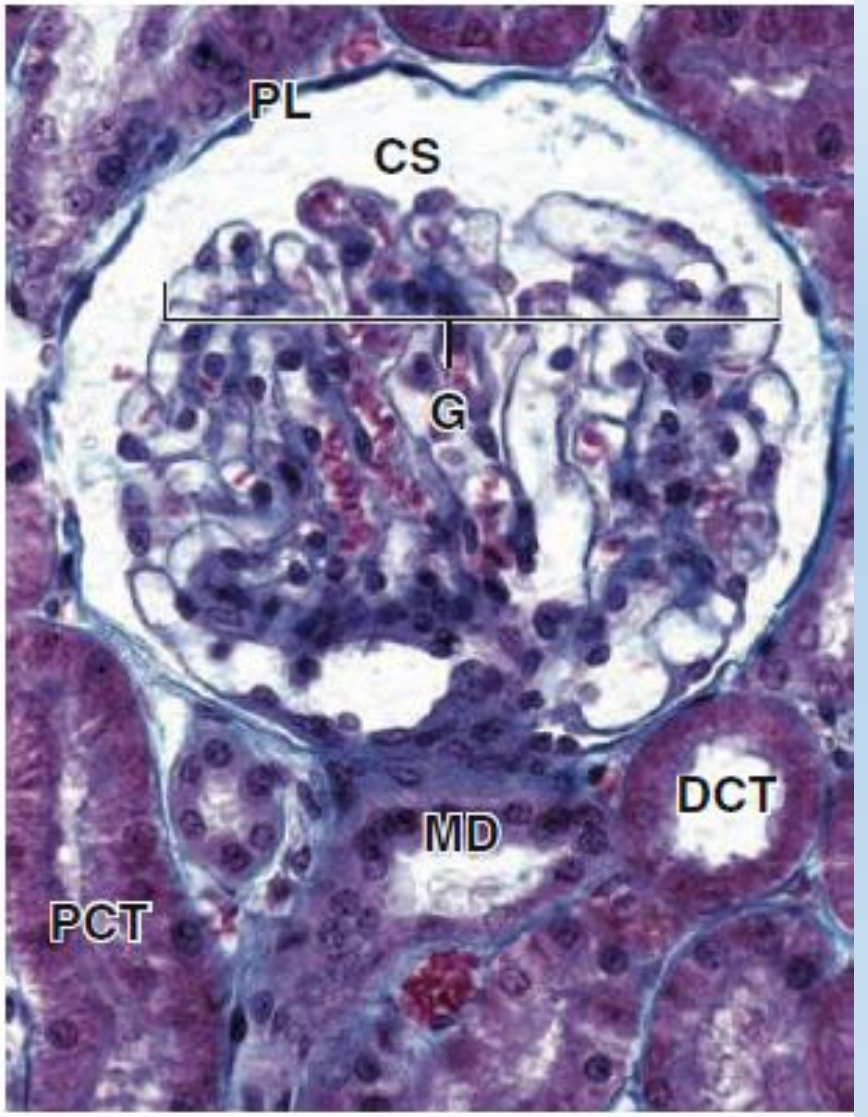

Macula densa
Connecting tubule
Glomerulus
Glomerular capsule:
Visceral layer
Parietal layer
Capsular space
Renal corpuscle
Cortex
Medulla
Connecting tubules
Collecting duct
Proximal convoluted tubule
Distal convoluted tubule
Loop of Henle:
Proximal straight tubule
Thin descending limb
Thin ascending limb
Thick ascending limb
Renal tubule

Region of Tubule	Histological Features	Locations
PCT	Simple cuboidal epithelium; cells well-stained, with numerous mitochondria, prominent basal folds and lateral interdigitations; long microvilli, lumens often occluded	Cortex
Loop of Henle		
Thin limbs	Simple squamous epithelium; few mitochondria	Medulla
TAL	Simple cuboidal epithelium; no microvilli, but many mitochondria	Medulla and medullary rays
DCT	Simple cuboidal epithelium; cells smaller than in PCT, short microvilli and basolateral folds, more empty lumens	Cortex
Collecting system		
Principal cells	Most abundant, cuboidal to columnar; pale-staining, distinct cell membranes	Medullary rays and medulla
Intercalated cells	Few and scattered; slightly darker staining	Medullary rays

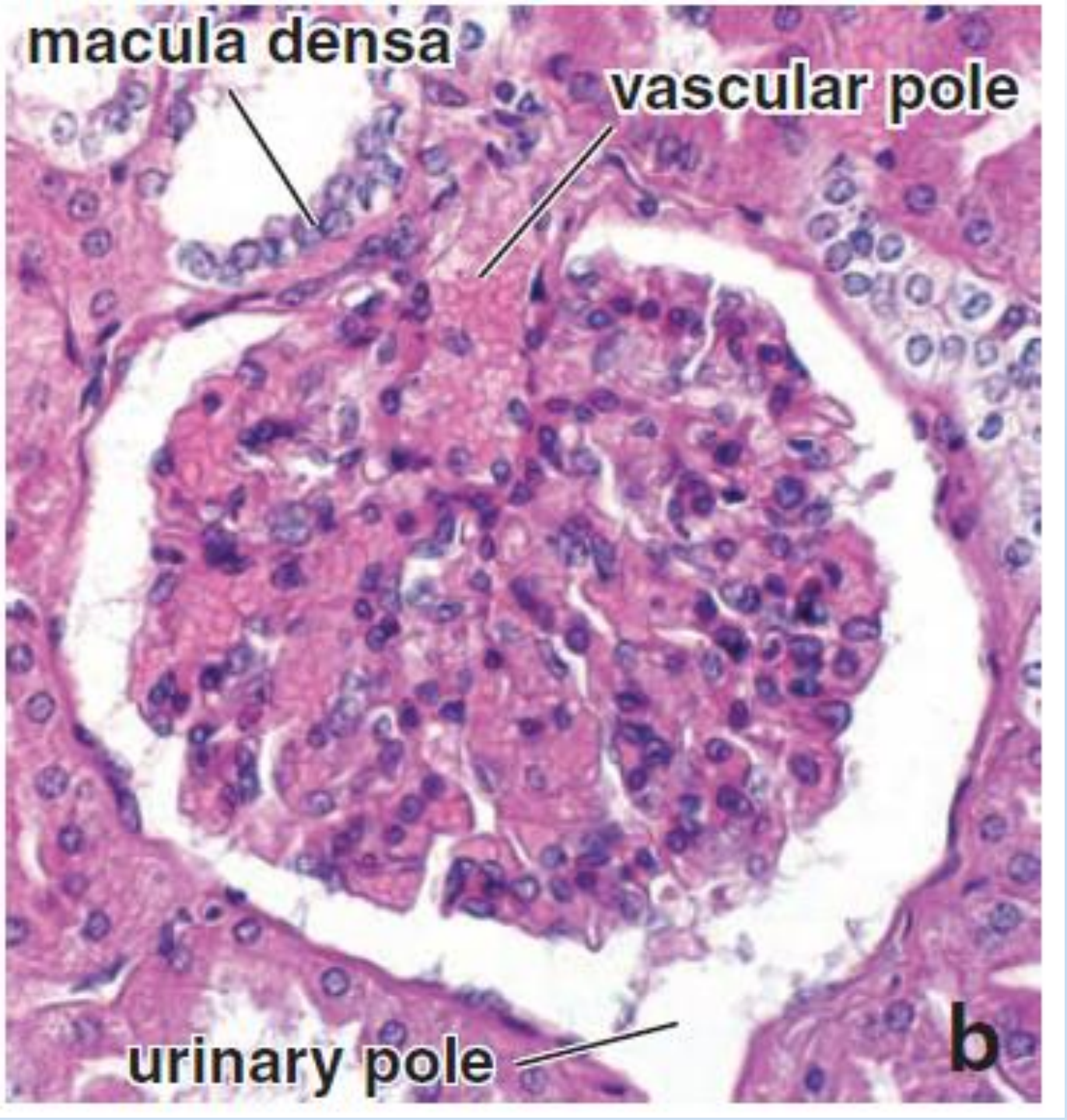
Dr. Omar AD

(b) Renal Corpuscle: The glomerulus (**G**) is surrounded by the capsular space (**CS**) covered by the simple squamous parietal layer (**PL**) of **Bowman capsule**. Near the corpuscle is that nephron's macula densa (**MD**) and sections of proximal convoluted tubules (**PCT**) and distal convoluted tubules (**DCT**). **Stain: H&E**

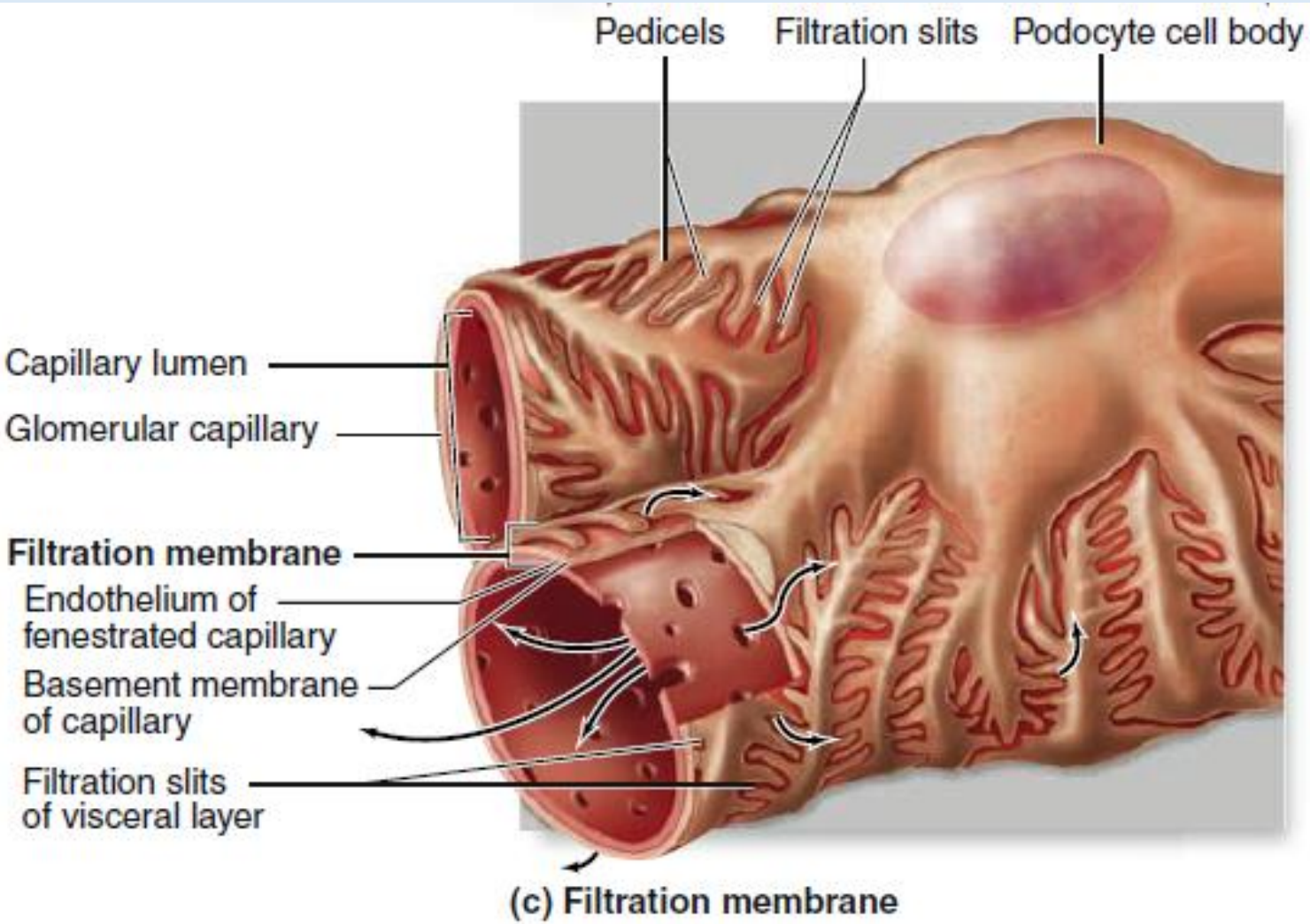




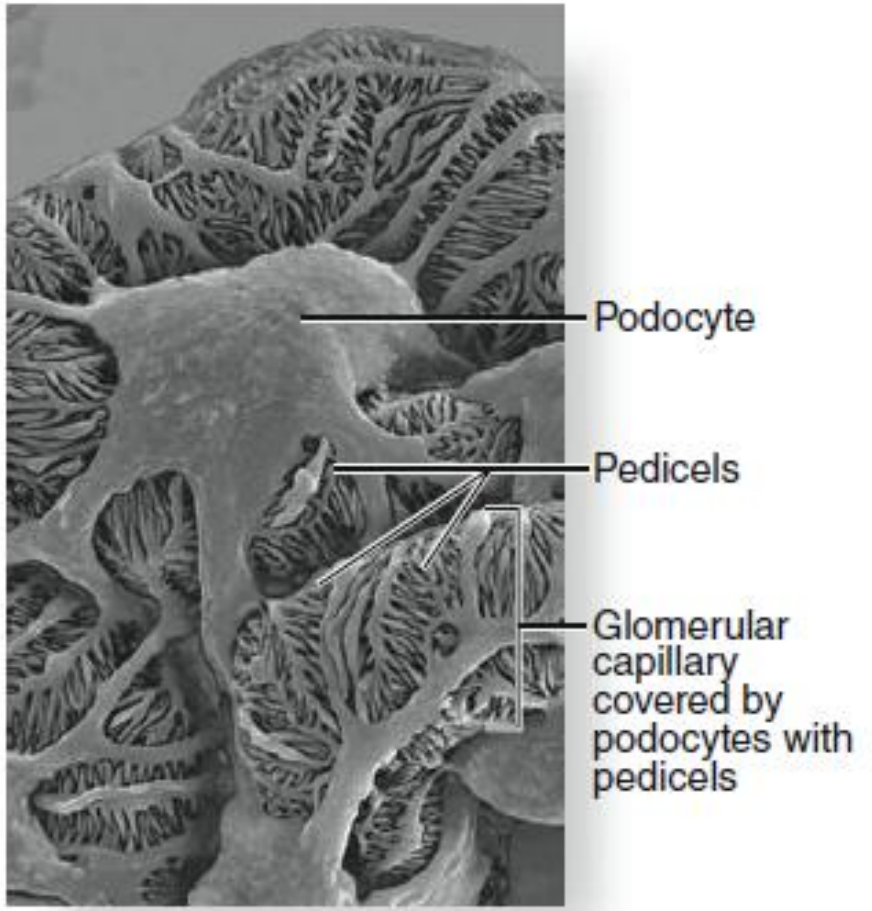
(b) Histology of renal corpuscle


macula densa
vascular pole
urinary pole
b

(d) The scanning electron microscopy (SEM) shows the podocytes and their pedicel processes that cover glomerular capillaries.

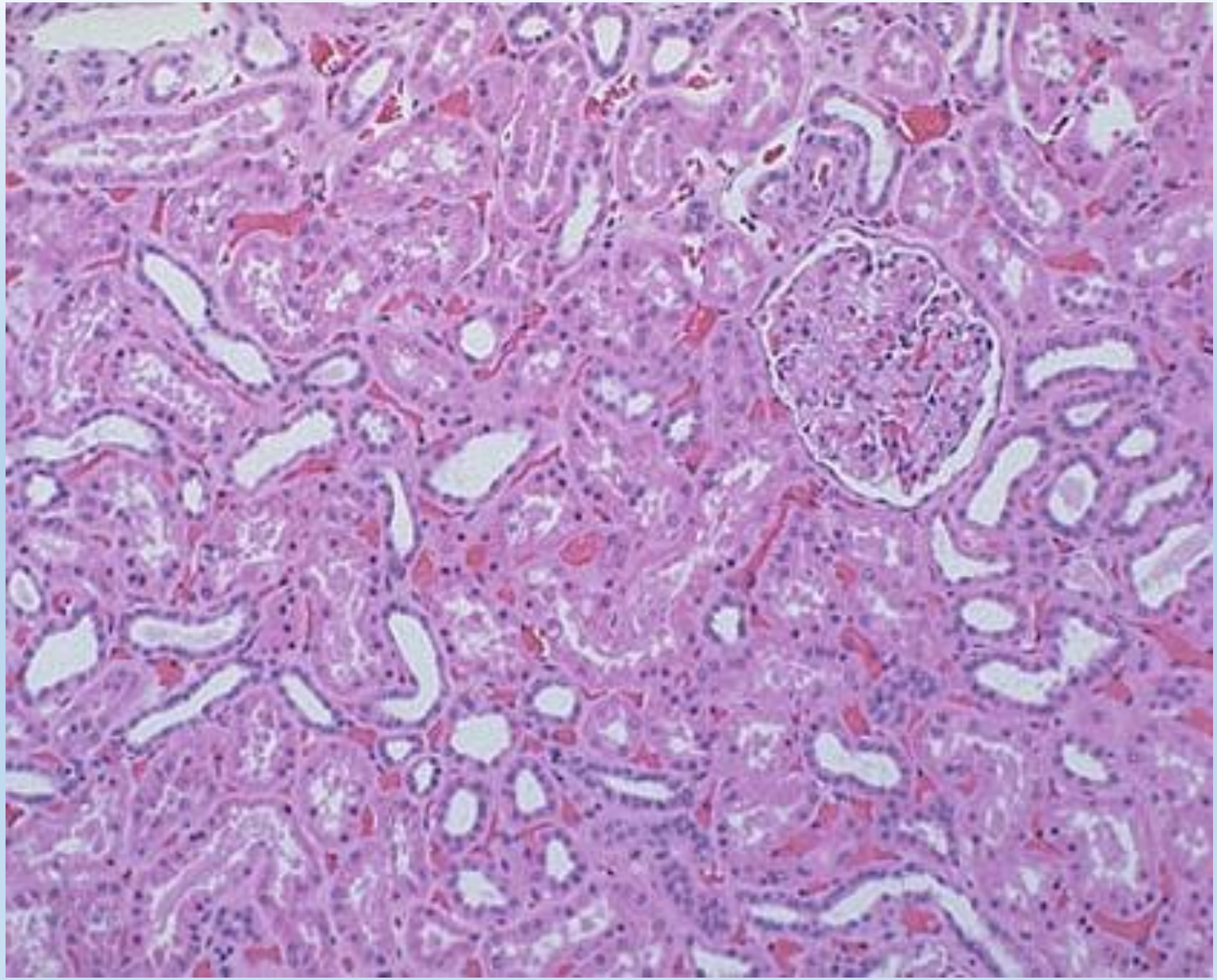


(c) Filtration membrane



(d) Podocytes

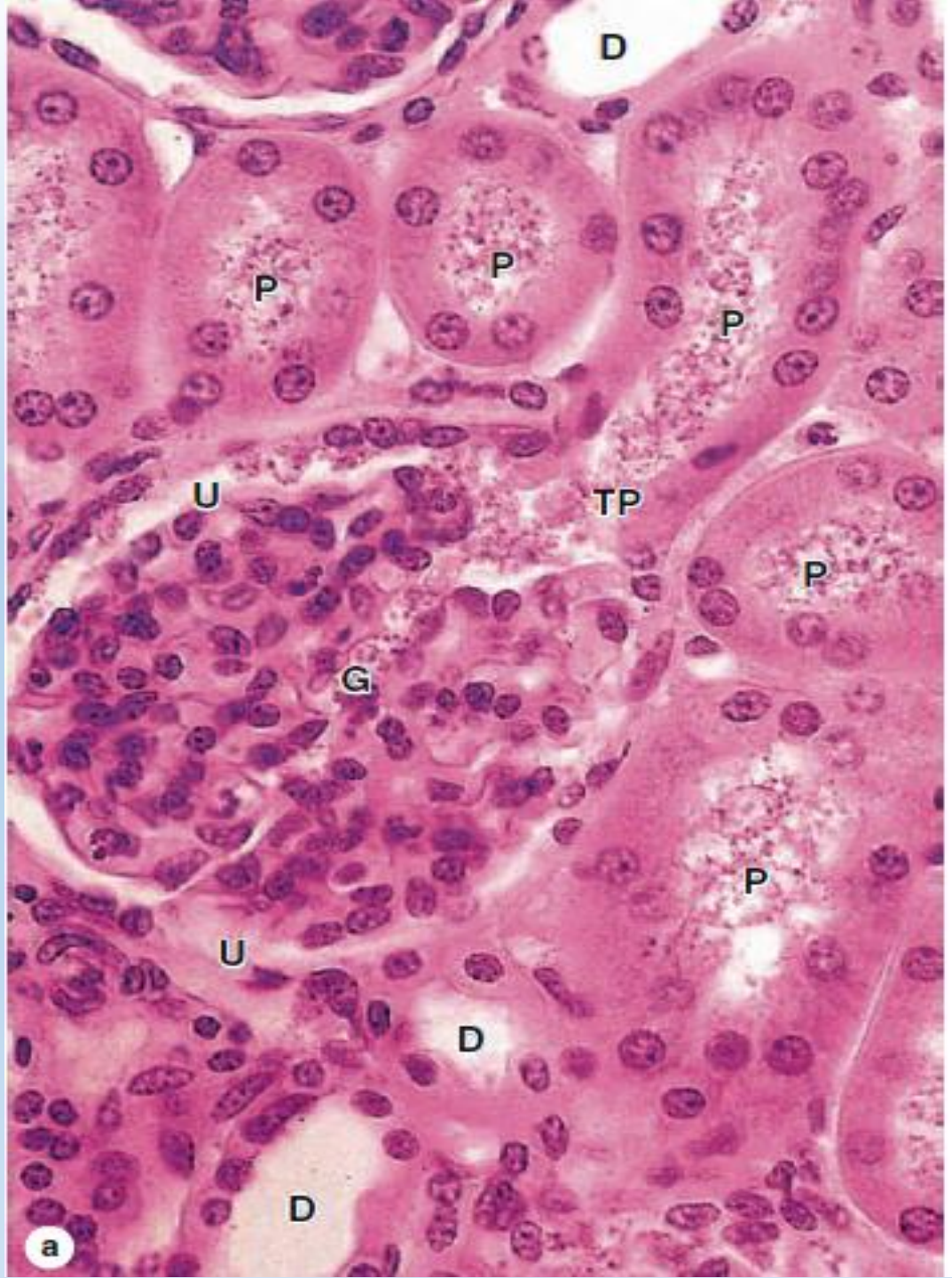
A normal **glomerulus** within the renal cortex seen at medium power has surrounding tubules.
The **proximal tubules** have a taller, pinker epithelium compared to the thinner epithelium of the **distal tubules**.



Renal Cortex:

The continuity of renal corpuscle's at tubular pole (**TP**) between the simple cuboidal epithelium of a proximal convoluted tubule (**P**) and the simple squamous epithelium of the capsule's parietal layer. The urinary space (**U**) drains into the proximal tubule. The lumens of the proximal tubules appear filled, because of the long microvilli of the brush border and aggregates of plasma proteins. By contrast, the lumens of distal convoluted tubules (**D**) appear empty, lacking a brush border and protein.

Stain: H&E

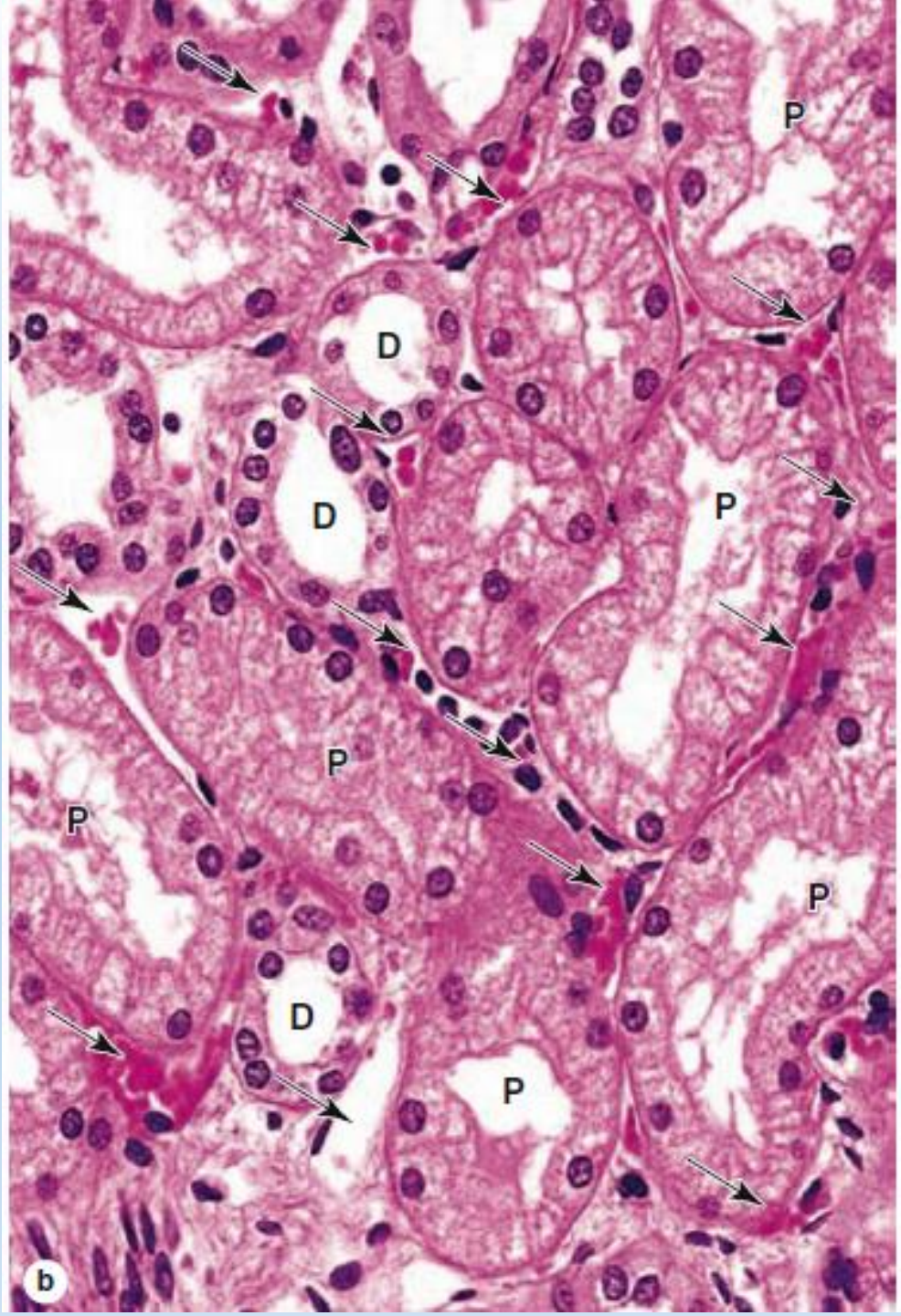


Renal Cortex:

The lumens of the proximal tubules appear filled, because of the long microvilli of the brush border and aggregates of plasma proteins. By contrast, the lumens of distal convoluted tubules (**D**) appear empty, lacking a brush border and protein.

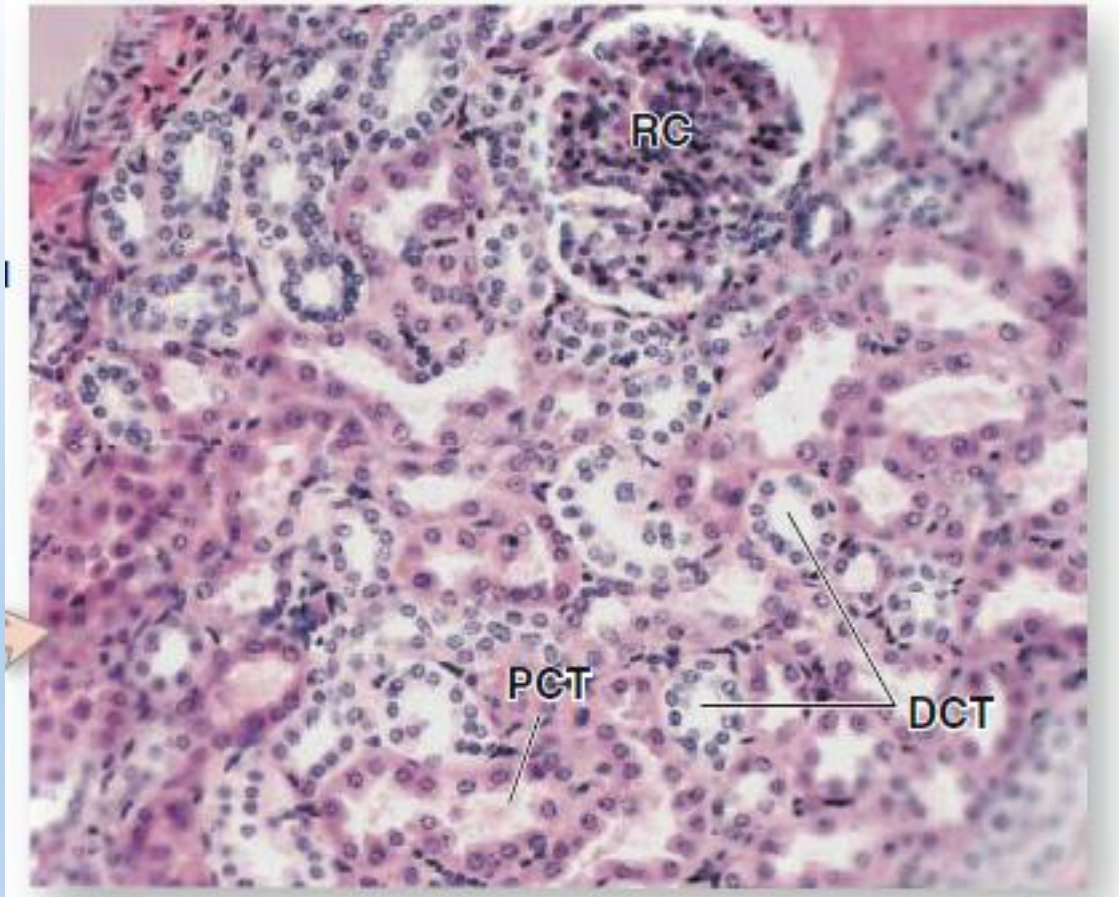
Here the abundant peritubular capillaries and draining venules (arrows) that surround the proximal (**P**) and distal (**D**) convoluted tubules are clearly seen.

Stain: H&E

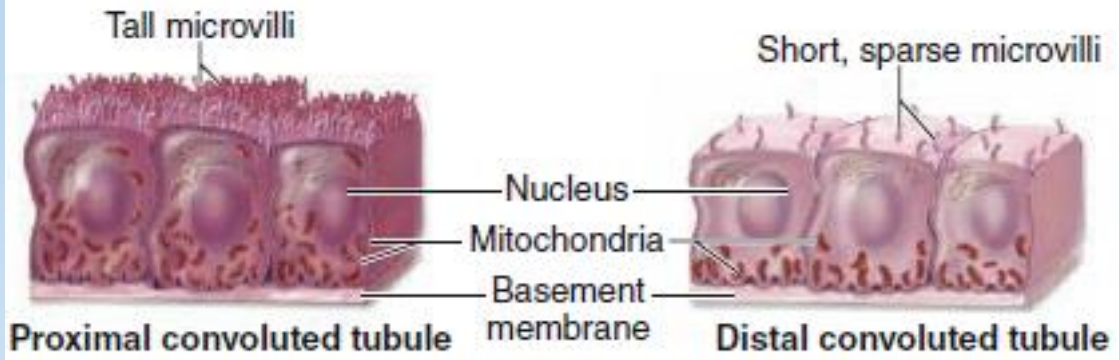


(b) Renal Cortex:
shows one renal corpuscle (**RC**), the wide, eosinophilic proximal convoluted tubules (**PCT**) with the smaller, less well-stained distal convoluted tubules (**DCT**). Stain: H&E.

(c) Diagram shows major differences between the cuboidal cells of proximal and distal tubules. Cells of both tubules have basal membrane invaginations associated with mitochondria.

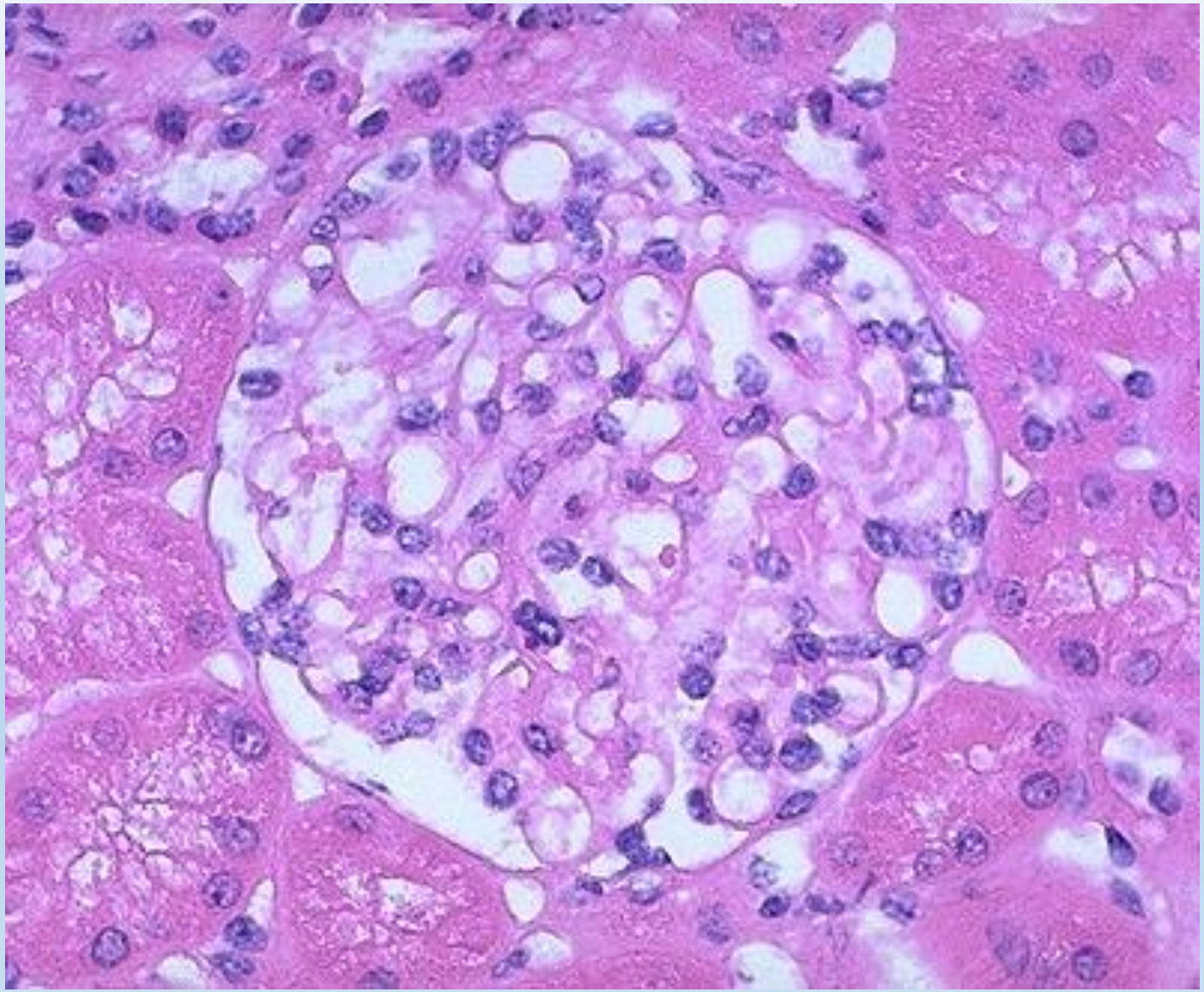


(b) Renal cortex



(c) Convoluted tubule epithelia

The normal glomerulus of the kidney at high power has thin, delicate **capillary loops** and the **mesangium** is not prominent. Actual glomerular filtration occurs in the capillary loops. The mesangium accounts for about 16% of filtration and serves a macrophage-like function and reparative function as well.

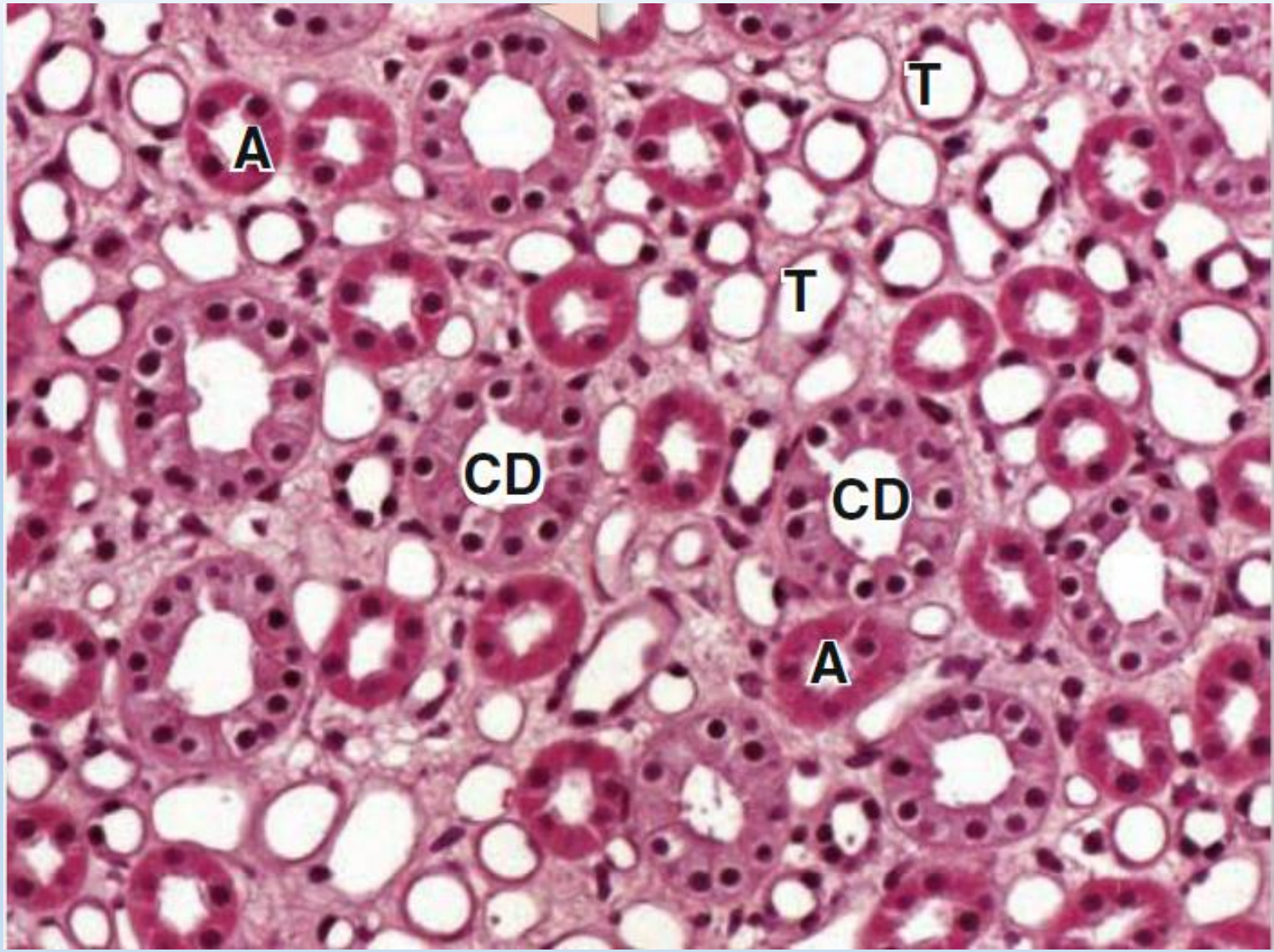


Renal Medulla:

A cross section through medullary renal pyramid shows the **simple squamous epithelium** of the thin descending and ascending limbs of loops of **Henle** (**T**) and its thick ascending limbs (**A**), as well as the pale columnar cells of collecting ducts (**CD**).

Note the capillaries smaller than the thin limbs.

Stain: Mallory trichrome.



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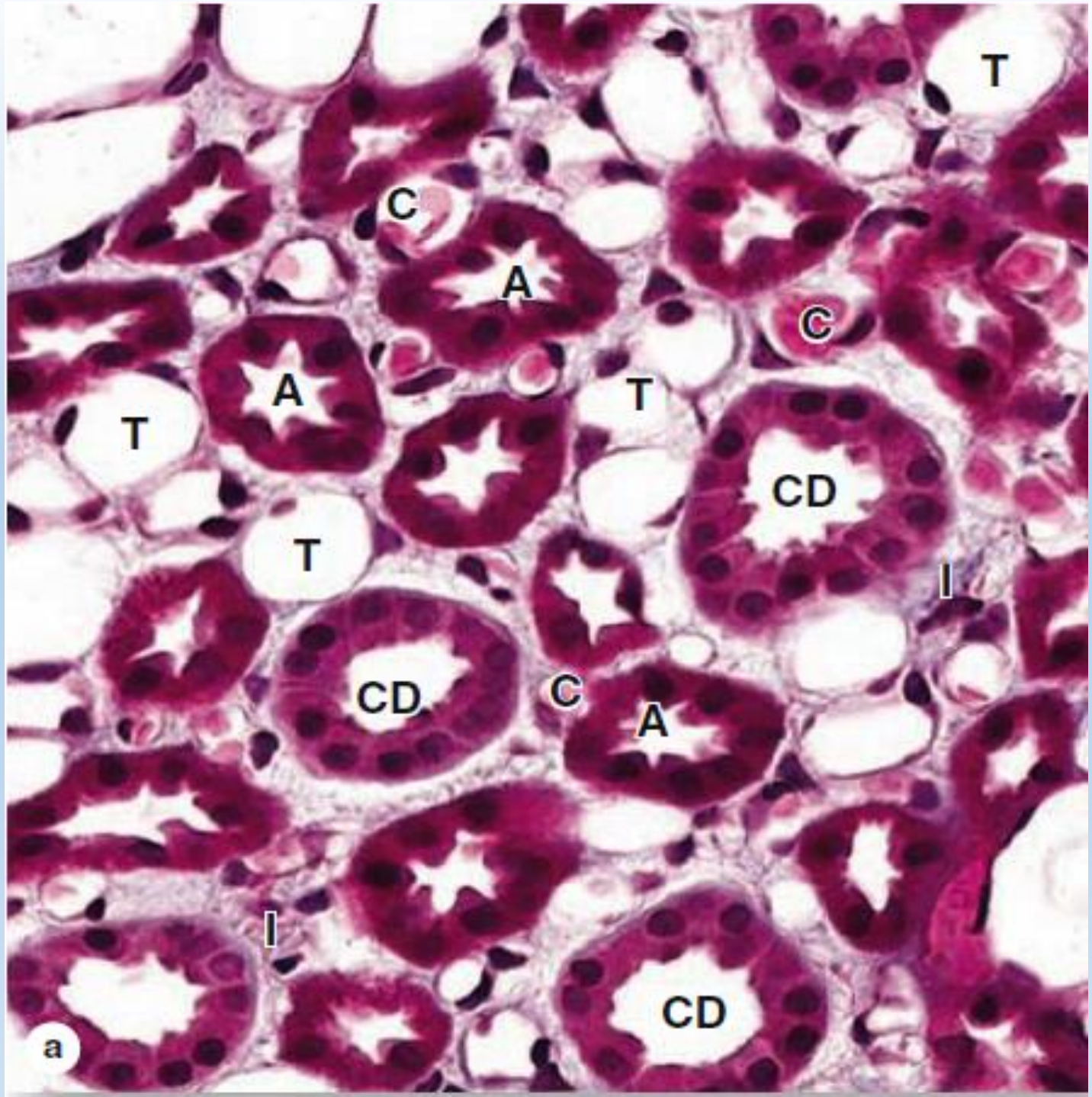
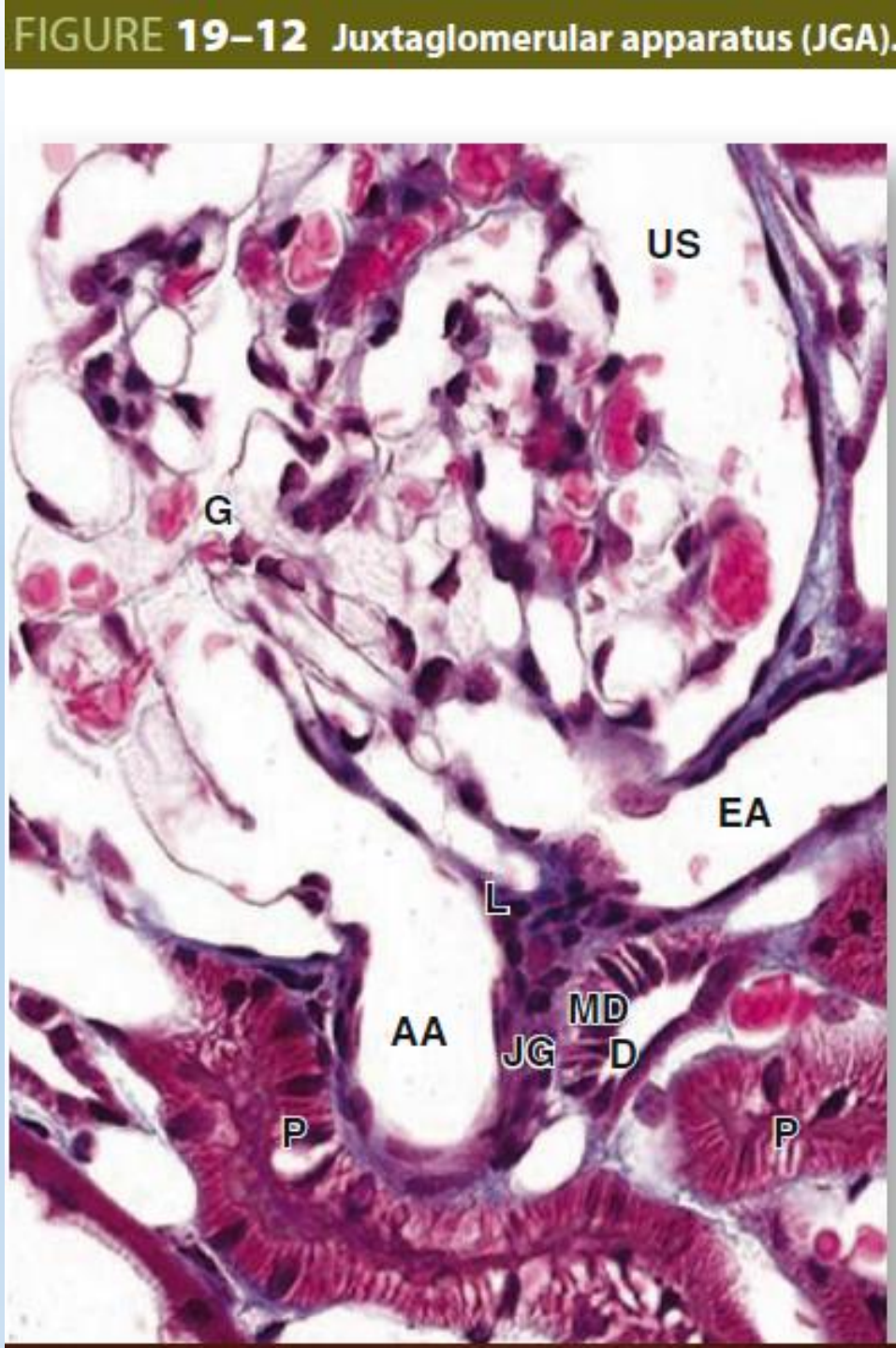


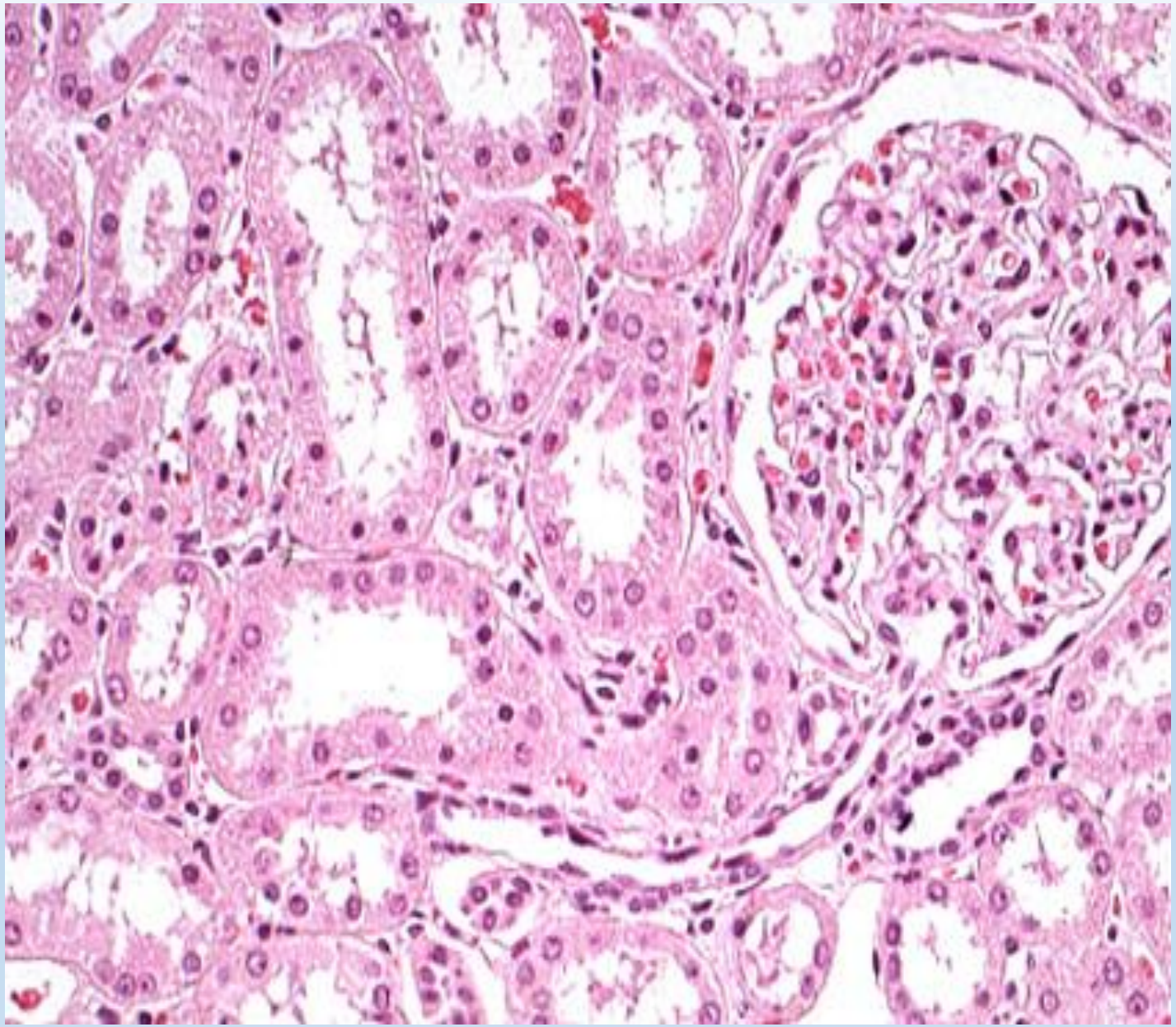
Juxtaglomerular Apparatus

The JGA forms at the point of contact between a distal tubule (**D**) and the vascular pole of its glomerulus (**G**). At that point, cells of the distal tubule become **columnar** as a thickened region called the **macula densa** (**MD**). Smooth muscle cells of the afferent arteriole's (**AA**) are converted from a contractile to a **secretory** morphology as **juxtaglomerular granule cells** (**JG**).
Also present are **lacis cells** (**L**), which are **mesangial** cells adjacent to the macula densa, the afferent arteriole, and the efferent arteriole (**EA**). In this specimen the lumens of proximal tubules (**P**) appear filled and the urinary space (**US**) is somewhat swollen.

Stain: Mallory trichrome.



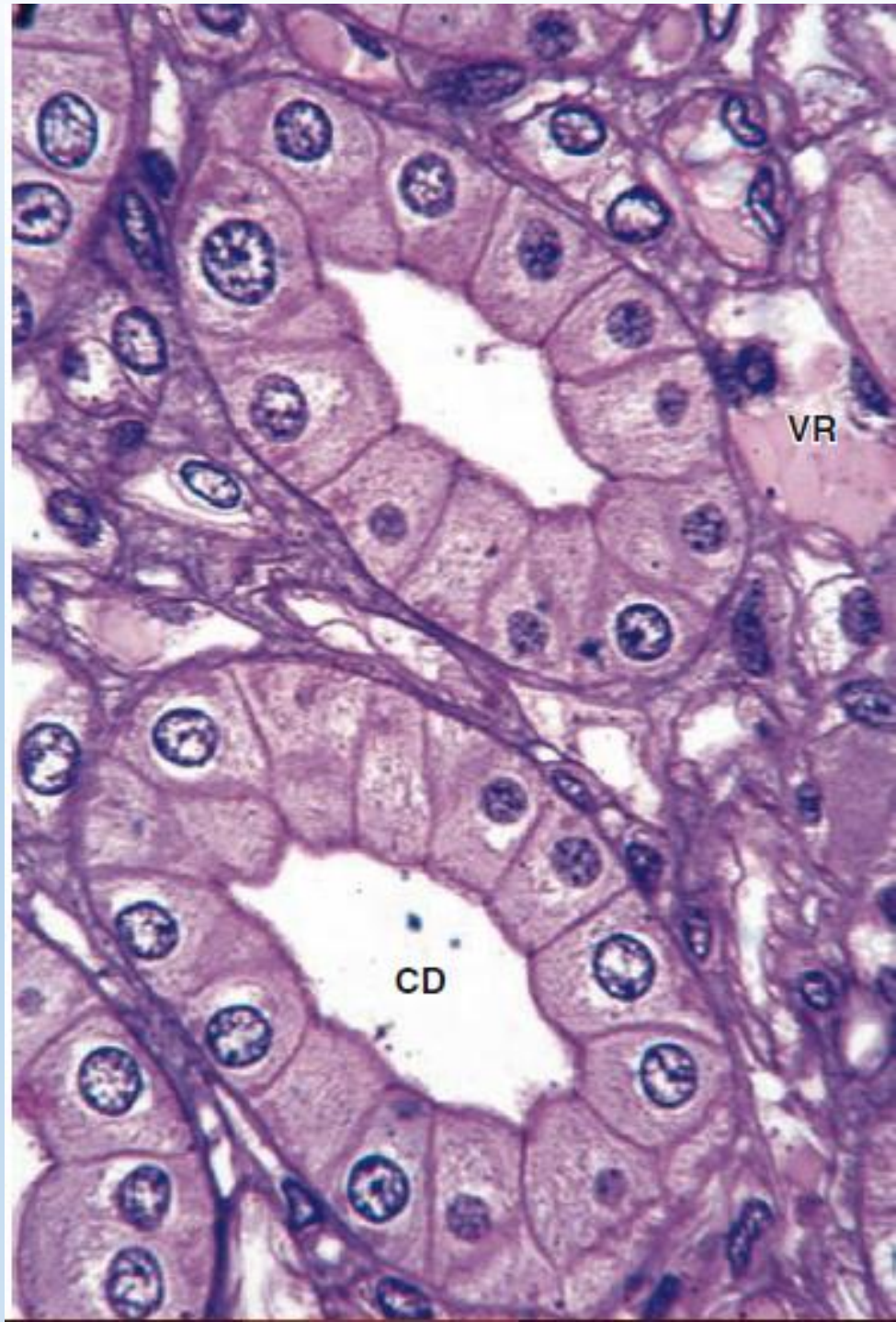
the juxtaglomerular apparatus really does exist. Seen here is the **afferent arteriole** entering the glomerulus at the vascular pole. The juxtaglomerular apparatus is a region of specialized smooth muscle cells called **JG cells** located in the afferent arteriole which, along with a set of columnar cells called the **macula densa** in the adjacent segment of distal convoluted tubule, sense changes in blood pressure and sodium concentration. The JG cells secrete renin to maintain blood pressure and volume control.



Collecting Ducts

Pale-staining columnar **principal cells** are clearly seen in these transversely sectioned collecting ducts (**CD**), surrounded by interstitium with vasa recta (**VR**).

Stain: PT.



Thank you..